

WORLD-CLASS OUTSTANDING INTERNATIONAL
PROGRAM | EXHIBITION | NETWORKING

Successful Online and Offline Cleaning of Steam Turbines With and Without Disassembly



42nd Turbomachinery
29th Pump SYMPOSIA

Successful Online and Offline Cleaning of Steam Turbines With and Without Disassembly

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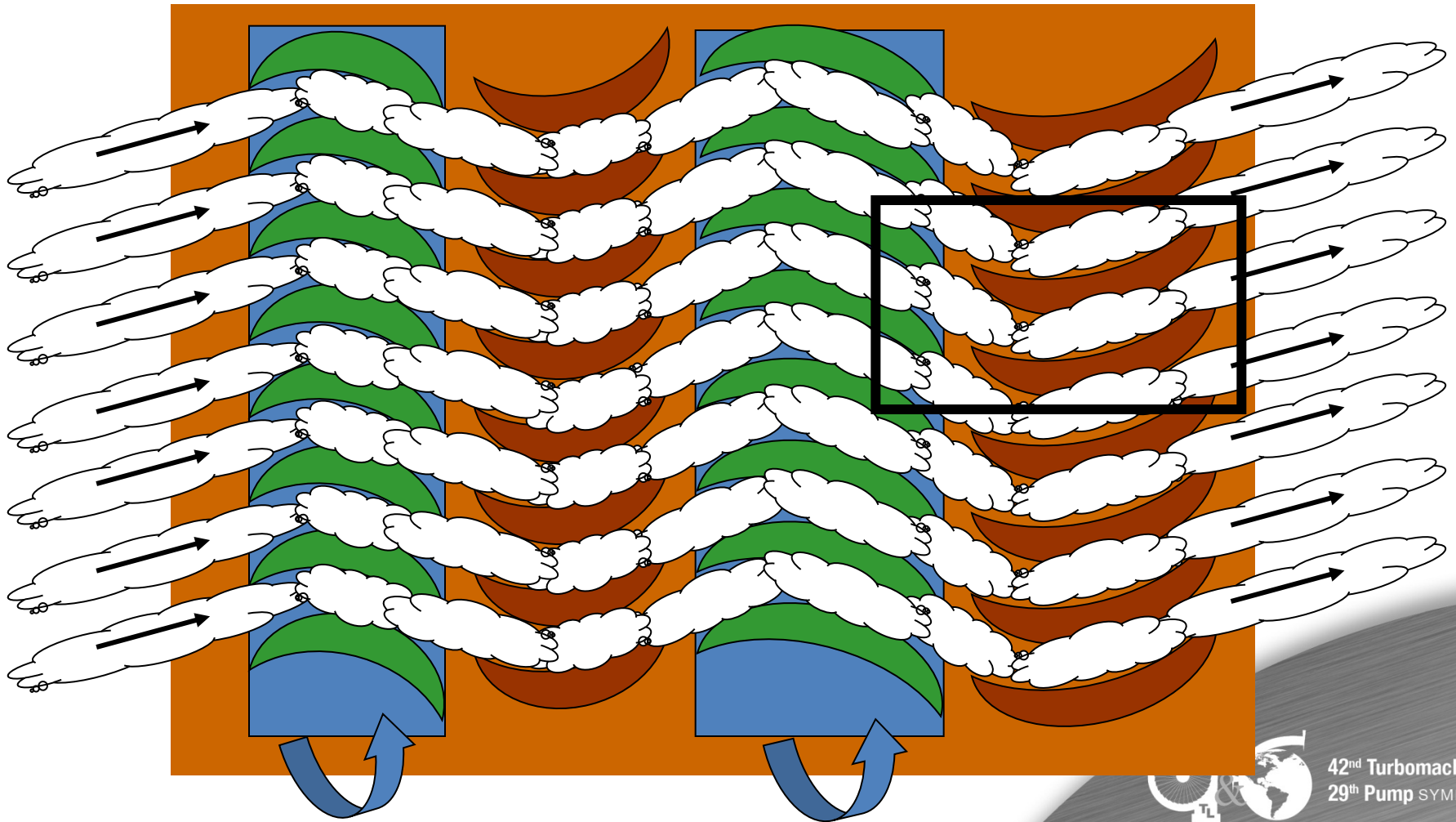
The Problem

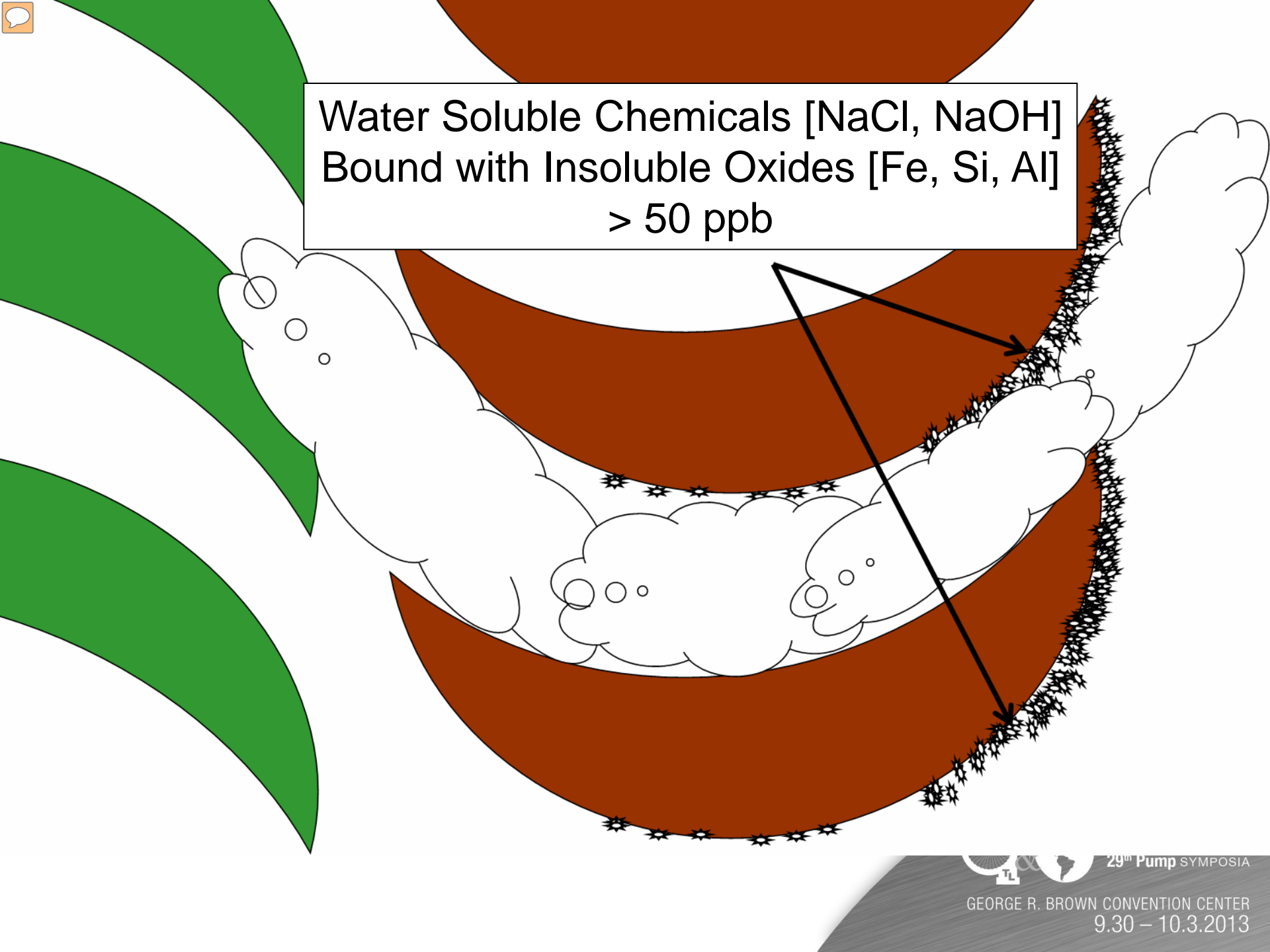
- steam turbines losing power and speed
- several occurrences isolated to multistage turbines driving critical compressors
- governor/steam valve unable to maintain desired rpm
- unit production reduced
- lost revenue



The cause of the problem?

fouling of turbine rotor blades and static guide vanes





Water Soluble Chemicals [NaCl, NaOH]
Bound with Insoluble Oxides [Fe, Si, Al]
> 50 ppb



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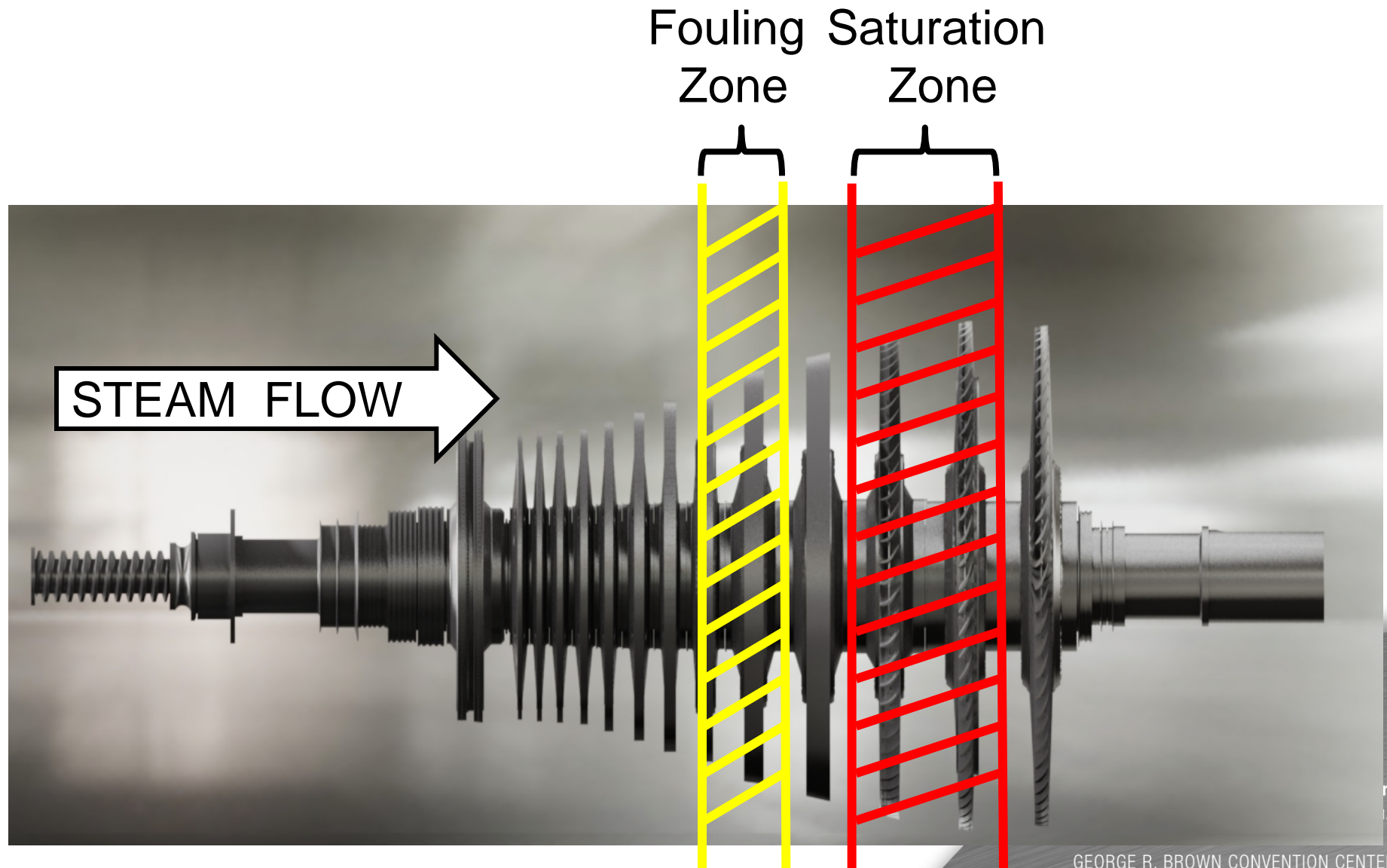


Photos showing fouling of diaphragm guide vanes



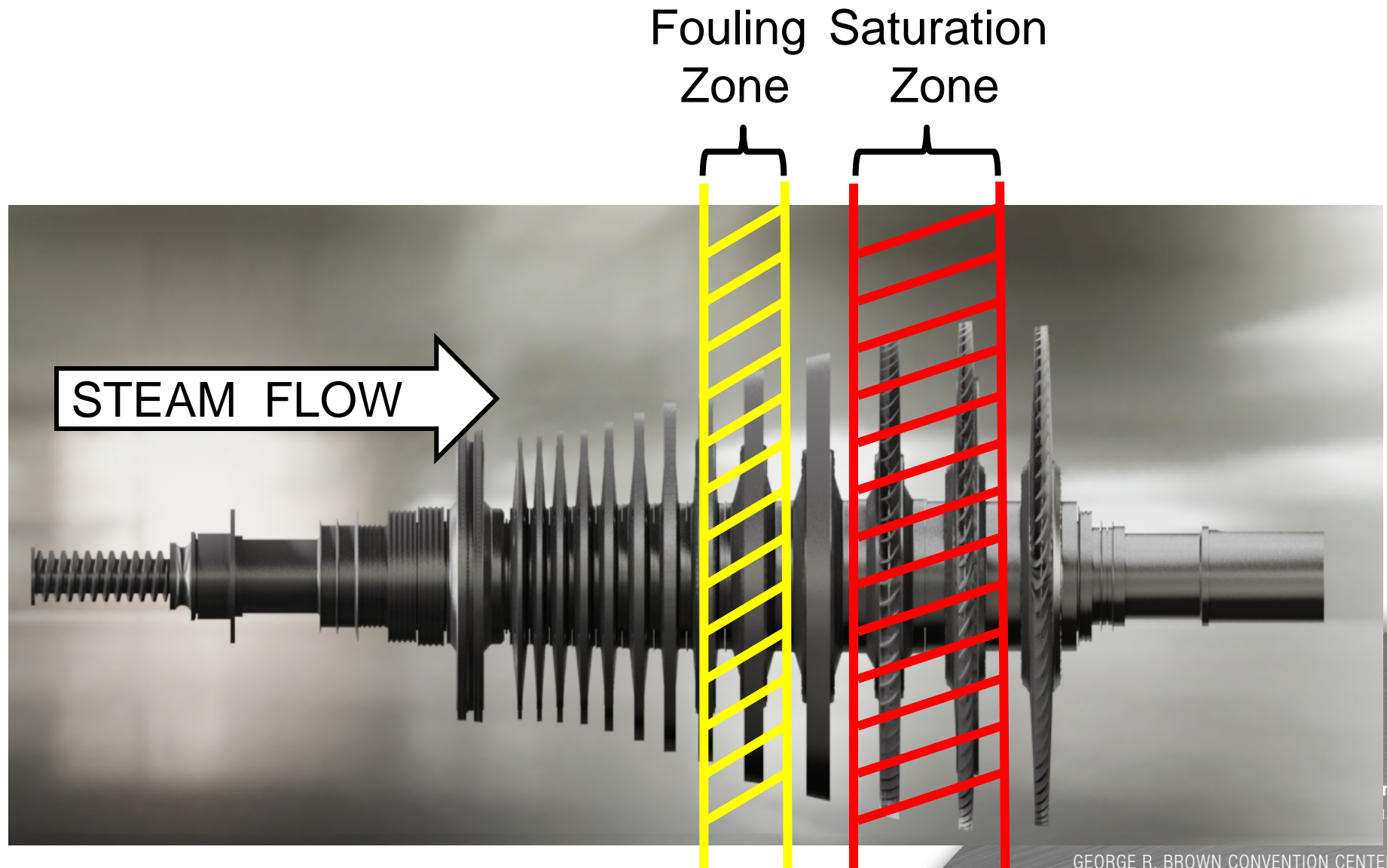


Fouling occurs in stages prior to saturation





To clean the turbine online,
move the saturation zone back to the fouling zone





Cleaning Methods Considered

1. Offline Mechanical Cleaning with aluminum oxide
 - Guaranteed results
 - Allows for inspection of rotor and other components
 - Requires disassembly
 - Extended downtime
 - Utilizes multiple resources
 - Intrusive



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Cleaning Methods Considered

2. Offline Slow-Roll Soak and Flush with Hot Water

- No disassembly
- Short Downtime
- Low Risk
- No modification of facilities
- Results not guaranteed



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Cleaning Methods Considered

3. Online Manipulation of Saturation Point

- No disassembly
- No downtime but some lost production
- Medium risk managing axial thrust
- No modification of facilities
- Results not guaranteed



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Cleaning Methods Considered

4. Online Water Injection into Steam at Turbine Inlet

- No disassembly
- Medium risk managing axial thrust
- No downtime for cleaning but
- Requires modifications of facilities (downtime)
- Results not guaranteed



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Turbine #1

3-Stage Turbine, No Extraction, No Turning Gear

Selected Cleaning Method –

1. Offline Mechanical Cleaning
(disassembly)

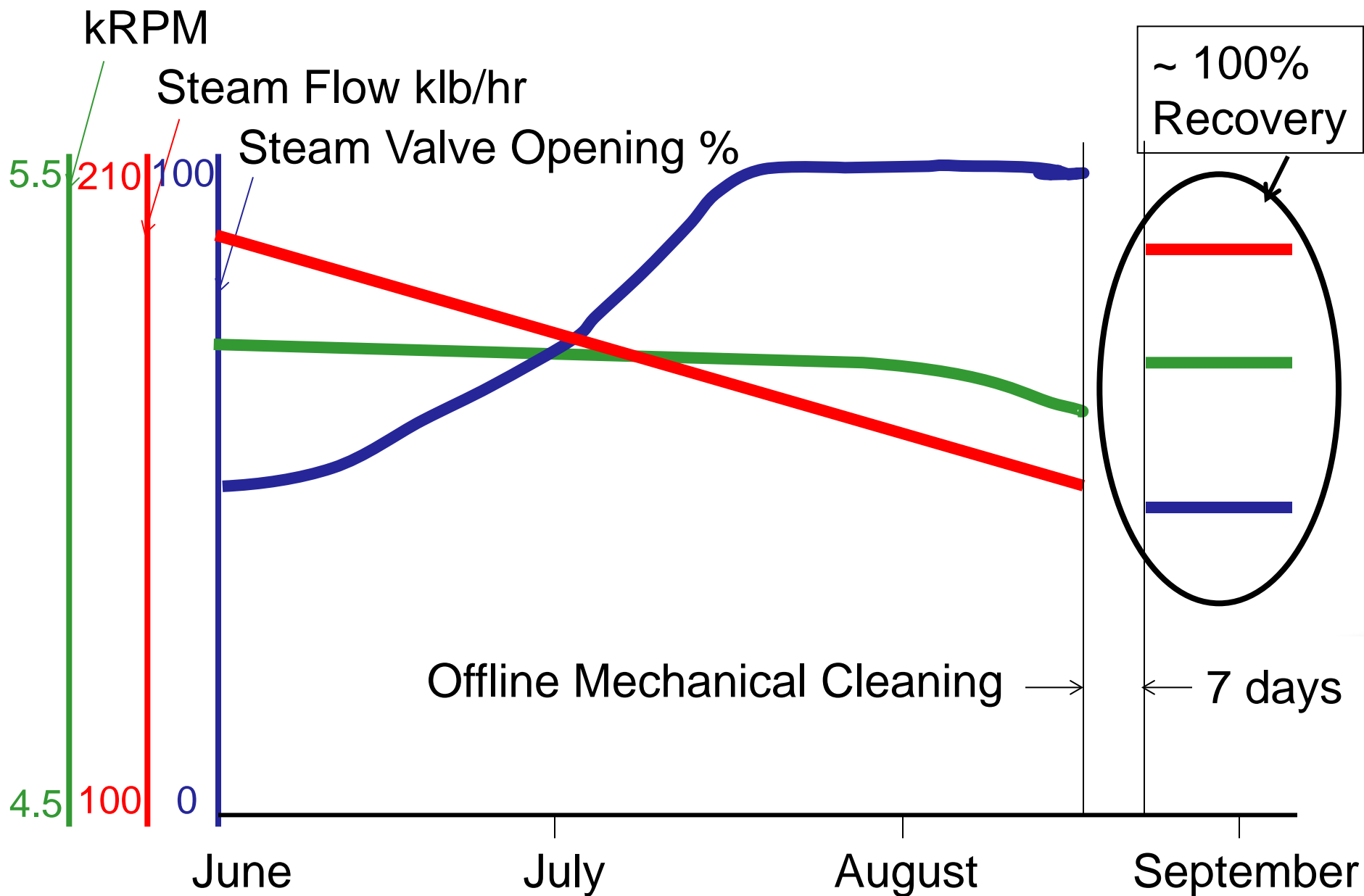


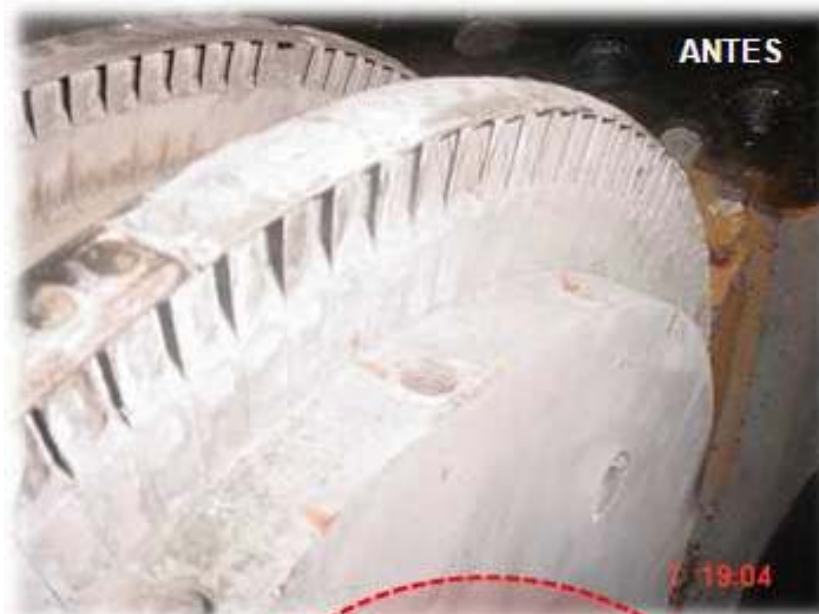
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Turbine #1 Performance Before and After Cleaning





ANTES

7 19:04



DESPUES

*Removidos en 100 % de las partículas solubles y
No solubles inscruadas sobre las etapas de la
CT-2601.*

4 17:54



*Presencia de capas delgadas de Silice
Inscruadas en la ultima etapa del CT-2601.*

1 19:04



machinery
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Turbine #2

10-Stage Turbine, Has Extraction, Has Turning Gear

Selected Cleaning Method –

2. Offline Slow Roll Soak with Hot Water
(no disassembly)



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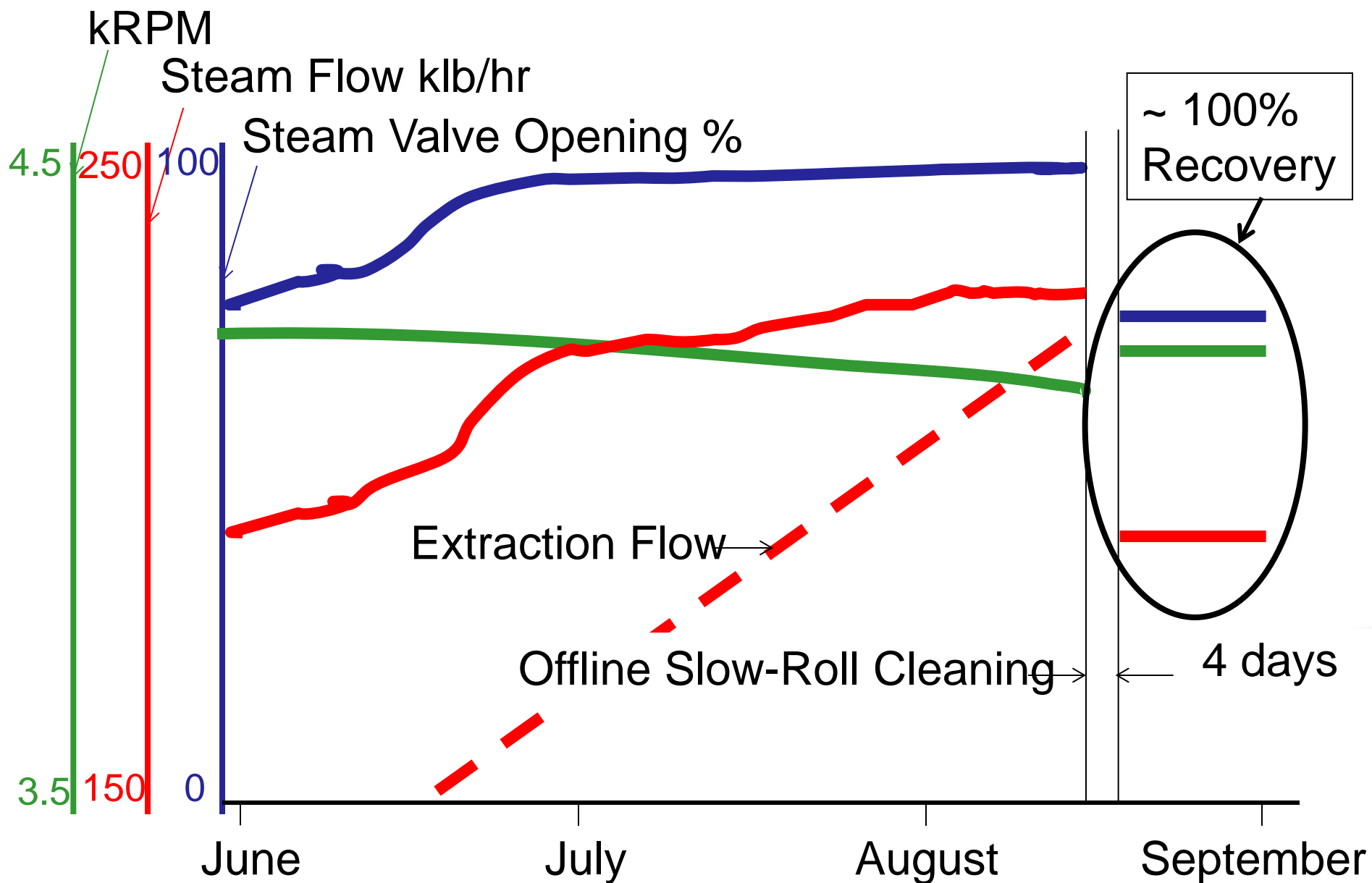


Slow-Roll Soak Cleaning Procedure

1. Develop Plan for measuring conductivity (hardness) of water exiting turbine
2. Shut down turbine/compressor and place on slow roll using turning gear
3. Close all valves except for sentinel valve and leaving free flow open to/from condenser
4. Slowly fill turbine to 100% by flooding condenser with hot water/condensate allowing overflow from the sentinel valve
5. Allow turbine to slow roll with water flowing for several hours while monitoring conductivity (hardness). When conductivity becomes equal to water flowing in, cleaning is complete.

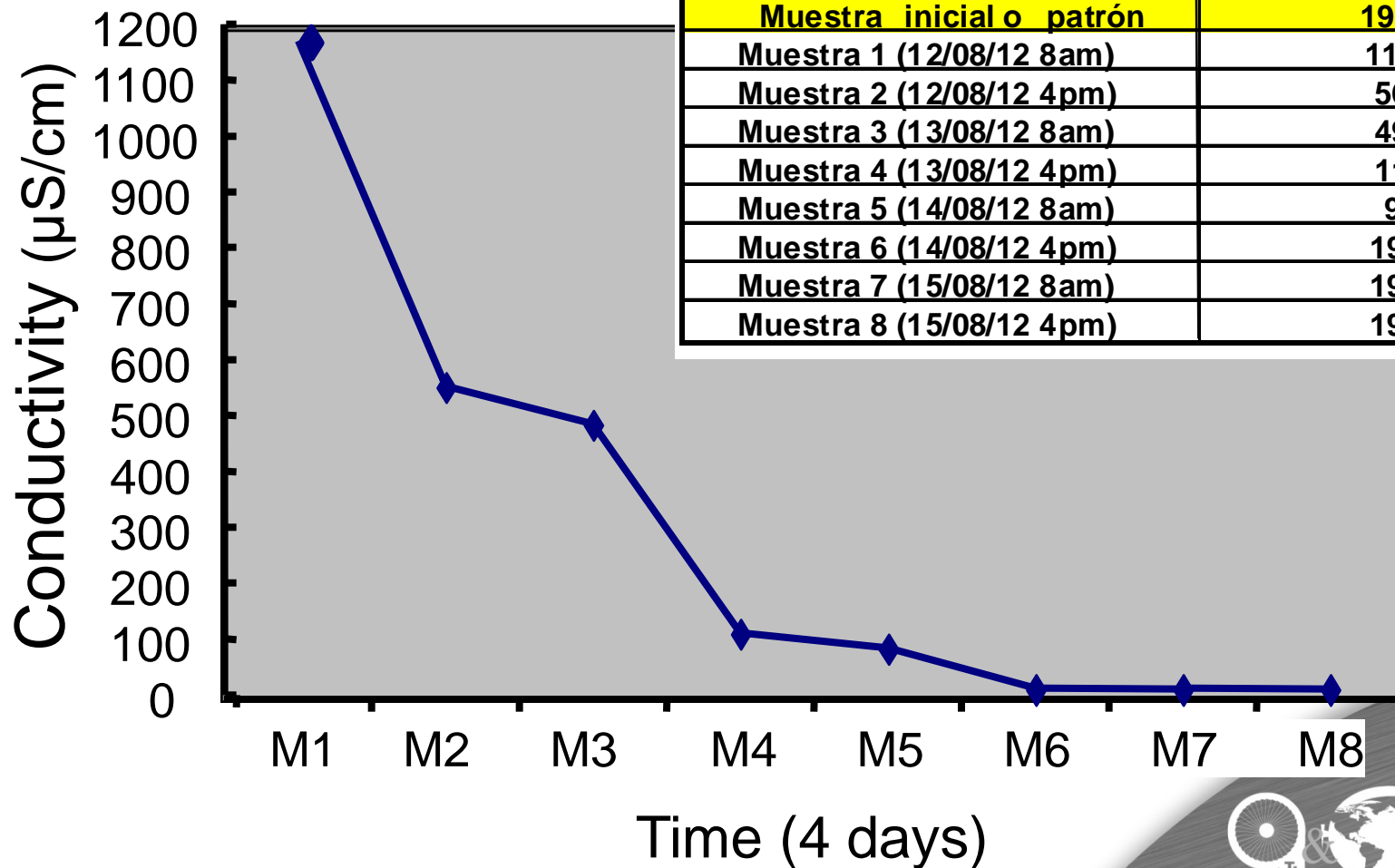


Turbine #2 Performance Before and After Cleaning



Conductivity Reduction During Cleaning

Conductivity of Condensate During Cleaning



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Conclusions

Solid deposits of both soluble and insoluble material can be safely and effectively removed from turbine blades and guide vanes.

There are removal methods available that do not require disassembly of the turbine.



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Conclusions

The key mechanism for removing the solids without disassembly of the machinery is to dissolve the soluble material thus releasing the insoluble material.

This may be done by:

1. Flushing with hot water while slow rolling the turbine or
2. Moving the saturation zone back through the fouling zone at normal RPM while monitoring conductivity (hardness).